R E P O R T R E S U M E S

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EVALUATION OF THE MADISON PROJECT METHOD OF TEACHING IN ARITHMETIC SITUATIONS, GRADES 4, 5, AND 6.

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FOUR HYPOTHESES WERE CONSIDERED DURING THIS EVALUATION STUDY, NAMELY THAT THE TEACHING OF ARITHMETIC IN GRADES 4, 5, AND 6 BY THE MADISON PROJECT WILL--(1) PRODUCE AS GREAT AN INCREASE IN ACHIEVEMENT AS THE METHOD COMMONLY PRACTICED, (2) PRODUCE A GREATER INCREASE IN ALGEBRAIC APTITUDE, (3) PRODUCE A GREATER INTEREST IN MATHEMATICS, AND (4) INFLUENCE CHANGES IN THE SCORES OF STUDENTS ON A TEST OF ABSTRACT THINKING EQUAL TO CHANGES EXPERIENCED BY STUDENTS RECEIVING INSTRUCTION AS COMMONLY PRACTICED. TWENTY-SIX TEACHERS IN SYRACUSE, NEW YORK, WERE SELECTED FOR PARTICIPATION AND WERE RANDOMLY DIVIDED INTO EXPERIMENTAL AND CONTROL GROUPS. STUDENTS IN ARITHMETIC CLASSES IN SYRACUSE PUBLIC SCHOOLS PARTICIPATED FOR ONE SCHOOL YEAR. INSTRUMENTS WHICH MEASURED INTELLECTUAL LEVEL, ALGEBRAIC APTITUDE, ARITHMETICAL ACHIEVEMENT, AND INTEREST IN MATHEMATICS WERE ADMINISTERED AT THE BEGINNING AND END OF THE SCHOOL YEAR. COMPARISON OF THESE, PRE- AND POST-TESTING DATA REVEALED THAT STUDENTS IN THE EXPERIMENTAL GROUPS INCREASED THEIR SKILL AND UNDERSTANDING OF COMPLEX MATHEMATICAL PRESENTATIONS, AND AT THE SAME TIME APPARENTLY DID NOT LOSE ANY ABILITY TO BE SUCCESSFUL IN CONVENTIONAL ARITHMETIC ACHIEVEMENT AS MEASURED BY TESTS. INCONSISTENCIES WERE NOTED FOR BOTH EXPERIMENTAL AND CONTROL GROUPS IN THE ANALYSIS OF STUDENT ATTITUDES TOWARD ARITHMETIC AS MEASURED BY THE QUESTIONNAIRE. (WB)

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Evaluation of the Madison Project Method of Teaching in Arithmetic Situations, Grades 4, 5, and 6

Cooperative Research Project No. 1193

William F. Bowin

New York State Department of Education

and

Board of Education, City School District
Syracuse, New York

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PROBLEM

The study was designed to evaluate the effectiveness of the Madison Project method of teaching arithmetic which purports to develop a readiness for higher mathematics and a keener insight into fundamental arithmetic through early experience in solving algebraic problems. The Madison Project attempts to remove the emphasis on the memorization of steps and a mathematical vocabulary and place it on the creative thinking of the student. No controlled research has been done in the evaluation of this program at the present time. The outcome of this study has many implications in curriculum planning and teacher education and may open the door to further research in Syracuse and other areas of the country. Our arithmetic program in grades 1-6 emphasizes thinking with numbers in order that a child can handle problems involving numbers and quantities. In the development of our program we include arithmetic language meanings, understandings, and skill in the use of numbers, the four processes, fractions, decimals, measurement and problems involving these learnings.

The Madison Project concerns itself primarily with the teaching of mathematics in grades 3 through 9. Its main objective is to present basic mathematical concepts clearly and logically. To do this, the child develops his ideas through the Socratic method of teaching. A sequence of mathematical problems are presented which will lead to the discovery of patterns and concepts.

OBJECTIVES AND/OR HYPOTHESES

Four experimental hypotheses will be considered:

A. The teaching of arithmetic in grades 4, 5, and 6 by the Madison Project method will produce as great an increase in achievement in arithmetic as the teaching of arithmetic as commonly practiced in Syracuse.

B. The teaching of arithmetic in grades 4, 5, and 6 by the Madison Project method will produce a greater increase in algebraic aptitude than the teaching of arithmetic as commonly practiced in Syracuse.

C. The teaching of arithmetic in grades 4, 5, and 6 by the Madison Project method will produce a greater interest in mathematics than the teaching of arithmetic as commonly practiced in Syracuse.

D. Students receiving instruction in grades 4, 5, and 6 by the Madison Project method will experience changes in scores on a test of abstract thinking equal to students receiving instruction in arithmetic as commonly practiced in Syracuse.

RELATED RESEARCH

Little experimental research has been completed in this field. Various committees and groups have studied the basic problem of presenting mathematical concepts at elementary levels in order to provide a smoother swing into the secondary mathematics curriculum and to develop more interest in mathematical

concepts. The Elementary School Curriculum Committee of the National Council of Teachers studied this problem in 1958 under the chairmanship of J. Fred Weaver of Boston University. This group decided that there was a need for more emphasis on mathematical content in the elementary curriculum. They also suggested that research was needed in this field.

The University of Maryland Mathematics Project has worked on a similar problem of bringing the study of mathematical concepts into the junior high school curriculum. Evaluative procedures are still being carried out in this program. Other projects concerned with similar methods were: The School Mathematics Study Group under Professor Begle at Yale University, and the Minnesota National Laboratory for the Improvement of Secondary School Mathematics which did research on the School Mathematics Study Group Plan. Other plans could be mentioned which are similar in aim and in content, but upon which evaluative procedures have not been completed.

This is the current program in the Madison Mathematics experimental situation. Other studies have covered the early elementary years and the junior high school.* The initial study was a seventh grade experimental program where the Madison method was used exclusively with the experimental groups. It was felt that by supplanting conventional instruction completely it would be possible to measure the comprehensive effect of the new mathematics. After a year's experience with the Madison Mathematics program on a full-time basis, and after a careful examination of all available test scores and

*Experiment by City School District, William F. Bowin, Director, Syracuse, New York

other objective data, it was concluded that the goals of the Madison Mathematics Project were not consistent with the results obtained when standardized achievement tests were used. In other words, children in the control groups in the seventh grade project achieved significantly better than did their experimental counterparts. Many reasons have been advanced for this, none of which can be determined as final. Some suggestions for the effectual relationship of participation in Madison Mathematics to an apparent loss in achievement as measured by tests were as follows:

1. The new methodology lacks the intense focus of academic discipline that is found in conventional types of instruction.

2. There is a relationship between the teacher and pupil in the new programs that may inhibit traditional learning.

3. Our present arithmetic achievement tests do not adequately measure the goals of the Madison Mathematics methods.

Following the seventh grade study, basically the same youngsters were followed and studied in an eighth grade program.* It was felt that after a year of full-time instruction experimentally and after a careful review of all results for total groups and matched pairs, that a limited program in the new mathematics should be operated. Therefore, the design of the eighth grade program was such that children participating experimentally received Madison Mathematics instruction only once a week. This transferred the focus of total coverage to

*Experiment, City School District, Syracuse, New York
William F. Bowin, Director

that of curriculum enrichment or reinforcement. Because of the drastic reduction in the amount of programming, no significant changes in achievement were expected and none were observed.

Two programs that were presented at the seventh and eighth grade certainly could not be considered indicative of total results throughout the school. The supervisor of mathematics therefore suggested that the program be initiated at the third grade level* whereby early elementary youngsters would have some contact with the experimental programs. The results of this program indicated (the once-a-week plan was again adhered to) that there was a significant gain for the experimental group.

The present program is also an attempt to "fill out" the middle years of the elementary school and cover as much as possible of the total school organization. By far the largest number of youngsters were involved in this program, the design of which is described in the next section.

PROCEDURES

Preparatory activities in connection with the 4, 5, and 6 grade Madison Mathematics Project were begun the last week in July 1961. It was necessary to secure from the staff a list of volunteers who would be interested in participating in the Project as experimental and control teachers as there was considerable extra work demanded in the form of summer workshops. From the original list of 30 names 26 were selected

*Experiment, City School District, Syracuse, New York
William F. Bowin, Director

randomly to be placed in the experimental and control groups. There was no attempt to match teachers on the basis of any standard criteria. However, an initial review of names was conducted before they were placed in the experimental or control groups. A committee of three supervisors evaluated each selectee to determine if anything in the subject's approach to teaching (such as a casual or irresponsible attitude to extra responsibility) might deter him from being a successful participant.

The actual working on the project began when all of the elementary teachers of grades 4, 5, and 6 in the Syracuse public schools were notified that the New York State Education Department and the Department of Health, Education and Welfare of the United States Government had granted Syracuse the permission to expand the work of the Madison Project for teaching mathematics in grades 4, 5, and 6 for the school year 1961-1962. A meeting date was set for June 6, 1961 where teachers interested could learn more of the details of the program and could express a desire to participate. No restrictions were placed on teaching background.

From the large group of 50 teachers who expressed a desire to participate in the program a random selection of 26 teachers was made by Robert D. Purdy, Assistant Director of Research in the presence of William F. Bowin, director of the Project, Jane Downing, coordinator of the Project and Margaret Phelps, Supervisor of Intermediate Grades. Again a random selection

was made dividing the groups into thirteen experimental and thirteen control teachers. There was considerable concern about the extent or lack of teaching experiences and capabilities of the teachers selected in this manner. However, the program was designed to test the material and methods with heterogeneous teachers, students and schools, and this was done. There were many disappointed teachers who were most ambitious to "try out" the new material, but, by chance, were randomly selected as control. However, each group set out to do their best under the circumstances. Thirteen schools were represented by one or more teachers.

One week before the opening of school in the fall of 1961, an intensive workshop was conducted for the thirteen experimental teachers. Its purpose was to give an exposure to essential mathematical background and an introduction to the Madison Project method and materials. For each of these teachers it was a totally new experience. The majority of the teachers had had no mathematical training since secondary school. From 9:00 a.m. to 3:00 p.m. they listened, worked and questioned many times staying later to consult in smaller groups. Each teacher was presented the Madison Project material of Dr. Davis. As the new material was presented, they in turn planned how it would best be integrated in their special class and mathematics program. Specifically they worked on true, false, open sentences, inequalities, number systems including integers, coordinate graphing, sets identities,patterns, etc.

Although it was such a short time, the teachers felt this exposure to modern mathematics made them more comfortable to begin it with their students. Very few of the teachers had experienced the guided discovery method of teaching and it was difficult imagining taking a "back seat" in the classroom. It began to excite them and most of them became as skillful at questionning as at telling.

Semi-monthly workshops were held throughout the year. The time was divided between their questions and further teaching of new materials and clarification of old. Interest remained high throughout the year. A film of the Madison Project - Dr. Davis teaching - was shown.

During the school year, regular visitations were made to all of the teachers, both experimental and control. Most any visit involved some form of demonstration by the coordinator. Frequent phone calls and notes from the teachers asked for help in presenting a new topic, solving an old one or asking for material aids. Assistance was always given immediately and willingly. The principals of the schools involved were most interested and pleased to have had a part in the program.

The experimental groups were taught the Madison Project material the equivalent of one mathematics period per week. Some of the teachers devoted one whole period whereas others correlated it into the regular mathematics period daily whenever opportunity arose. The control teachers were allowed to use any materials or methods books, etc. as long as they did not teach Madison Project. They were supplied with visual aids of

all kinds. The Madison Project material by Dr. Robert Davis was present in every experimental teacher's room. This was the guide to the children's work.

The control teachers also met monthly to discuss their problems and other new projects were reviewed and considerable amount of enrichment was supplied by the teachers. It was noted that emphasis was placed in most every control class on drill and rote memorization for fast recall. Homework was assigned freely in mathematics in the control groups.

All of the "Project" teachers, both experimental and control, had the privilege of having guest consultants periodically throughout the year. In addition, the entire staff was invited to share the guests.

Due to the rigidity of internal structure, it was impossible to scientifically select pupils for these programs. We could only assume a randomization based on the premise that heterogeneous groups will provide approximately matched classes at varying degrees of ability. Pre testing in September of 1961 showed that little differences in ability of achievement levels were present. During the summer of 1961, the experimental teachers were exposed to several days of workshop exposure to the Madison methods.

MEASURING DEVICES OR PERTINENT VARIABLES

One of the most important considerations in any experimental program is the selection of the instruments to be used for variable measurement. The public schools have little opportunity

to use sophisticated or esoteric personality, character, or interest tests on a large scale basis. There are many reasons for this, the most common one being that parents are often unwilling to accept such an intrusion into their lives and that of their children. As one of the stated purposes of the Madison Mathematics Project is a claim to change interest or attitude toward mathematics in a more positive direction, it was necessary to develop our own interest device[1] (see appendix). This instrument was administered to all students in the Project on a pre- and post-testing basis. (Objective #1).

To estimate the intellectual level of subjects, the California Test of Mental Maturity[2], short form, elementary, was used in September of 1961 and June of 1962.

To determine if changes in arithmetic reasoning and arithmetic computation were occuring, tests A_1 and A_2 from the Iowa Test of Basic Skills[3] were administered to the experimental and control groups in September of 1961 and June of 1962 (Objective #2).

As the result of their experience with other programs, it was felt that some measure of ability on a test specifically designed and tailored to Madison Mathematics instruction should be given to both groups. This test, although be no means difficult, demanded a degree of understanding that certainly separated those students capable of advanced perception and

1 - Appendix 1 pages 21-22

2 - Appendix 2 page 28

3 - Appendix 3 page 29-31

sophisticated judgment. A copy of this test is appended[4] (Objective #3).

We wish to make clear our firm belief that pencil and paper tests are only an estimate of a youngster's ability, capacities and potential. Where objective data does not parallel our best thinking concerning the success or failure of a project, this should be no cause for frustration or discouragement. New programs have many things to contribute to the school curriculum that are not capable of objective, detached measurement.

ANALYSES OF THE DATA AND FINDINGS

A comparison of initial pre- and post-testing data points up several interesting trends. Both grade 4 control and experimental classes showed considerable gain over what might be expected in terms of normal growth. In all three sections of the Iowa Test (see tables 1 and 2)[5] significant gains were noted for both groups. The Syracuse Test of Algebraic Fluency[4] pointed up a significant gain in several of the experimental groups.

In grades 5 and 6 gains were less significant, although considerably beyond the expected achievement for both of these grades (see tables 3 and 4).[6] It is interesting to note that for the grade 6 experimental group a regression was noted from pre- and post-testing on the Syracuse Test of Algebraic Fluency.

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5 - Appendix 5 page 15

6 - Appendix 6 page 16

This was also true of this class' control counterpart and may be indicative of the type of children involved or a function of the test itself.

The relationships as established by the coefficient of correlation when pre- and post-test data was compared, except for one instance, do not deviate startlingly from what we might expect to find. It is immediately apparent that the ability to succeed on the Syracuse Test of Algebraic Fluency[4] and the ability to succeed on an intelligence test are not alike in their demands on the child. Throughout all three grades, low correlations were noted when these two tests were compared. Again we are comparing a test with a long history of standardization with another device that has no historical data behind it and has not been standardized on an extensive population. In other instances the STAF test also shows some low correlations between two tests which are essentially mathematical in nature. A question arises as to whether or not mathematical ability may be compartmentalized; is a child with a high degree of proficiency in understanding complex mathematical notation and advanced presentation necessarily penalized because he is not successful on another test that emphasizes quick recall of various arithmetical methods? In other words, on the basis of this data it is apparent the highly perceptive individual, or on the other hand, the arithmetically oriented individual may not have parallel chances of success on the respective test devices. This is an important distinction, we feel, in

4 Appendix 4 page 32-37

that a judgment must be made on whether or not present training methods in arithmetic should be modified severely or eliminated completely in favor of the intensive applications of those techniques that lead to keener perceptions and insight on the part of the individual.

Again it must be noted as it has been previously, that the results of pencil and paper tests often times are not consistent with the observed judgment of expert participants. Although the children in the program were subjected to an intense scrutiny, it was felt that at no time was there any evidence manifested to show that the interest and concern shown by all those participating in the Project affected the results of the test data in any way.

In summarization then, what is evidentally happening here is that youngsters in the experimental groups are increasing their skill and understanding of complex mathematical presentations, and at the same time, apparently not losing any ability to be successful on conventional arithmetic achievement as measured by tests.

ANALYSES OF INTEREST INVENTORY

In analyzing the attitudes of youngsters toward arithmetic by the Madison Mathematics attitude questionnaire,[1] considerable inconsistency was noted for both experimental and control groups. Although changes in attitudes are difficult to assess by means of a questionnaire, it was hoped that manifestations

[1] Appendix 1 page 21-22

of attitude change would appear in the format, pre and post.

The questionnaire was administered orally to counteract the effects of reading disability. It was explained to the experimental group that by arithmetic we meant the traditional number facts - combination theory as opposed to the special mathematics program they were involved in. Even with this, the results were puzzling.

Table 1
Pre and Post Summarization
Grade 4 Control

	Pre			Post		
Test	N	Mean	S.D.	Mean	S.D.	T
Iowa A_1	111	42.6	9.64	53.67	9.87	7.70*
Iowa A_2	111	39.8	5.63	54.74	10.29	13.30*
Iowa C	111	41.5	7.15	53.61	11.36	8.98*
Calif. Test Mental Mat.	107	112.9	19.54	113.3	18.95	1.02
Syracuse Test of Algebraic Fluency	105	17.03	4.37	17.30	4.02	.44

Table 2
Pre and Post Test Summarization
Grade 4 Experimental

	Pre			Post		
Test	N	Mean	S.D.	Mean	S.D.	T
Iowa A_1	113	43.8	9.16	56.0	6.42	10.20*
Iowa A_2	112	41.8	5.77	56.3	7.10	13.53*
Iowa C	112	43.1	6.63	56.3	8.96	13.07*
Calif. Test Mental Mat.	108	112.3	18.75	112.57	19.91	.98
Syracuse Test of Algebraic Fluency	109	17.3	3.63	19.17	3.63	3.91*

*Significant at .005 level

Table 3
Pre and Post Test Summarization
Grade 5 Control

	Pre			Post		
Test	N	Mean	S.D.	Mean	S.D.	T
Iowa A_1	95	54.0	9.4	60.15	8.31	4.79*
Iowa A_2	92	53.8	8.05	61.27	11.4	5.10*
Iowa C	92	54.1	7.82	61.03	8.93	5.60*
Calif. Test Mental Mat.	89	107.0	15.25	106.68	14.93	.75
Syracuse Test of Algebraic Fluency	74	17.31	3.87	17.68	9.28	.71

Table 4
Pre and Post Test Summarization
Grade 5 Experimental

	Pre			Post		
Test	N	Mean	S.D.	Mean	S.D.	T
Iowa A_1	110	46.9	13.36	58.63	11.39	6.39*
Iowa A_2	108	47.16	10.83	58.14	13.44	6.69*
Iowa C	108	47.54	11.29	59.72	11.86	7.21*
Calif. Test Mental Mat.	113	106.8	18.37	108.3	19.79	1.01**
Syracuse Test of Algebraic Fluency	108	16.18	5.03	17.27	3.75	1.83***

*Significant at the .005 level

**Significant at the .10 level

***Significant at the .05 level

Table 5
Pre and Post Test Summarization
Grade 6 Control

	Pre			Post		
	N	Mean	S.D.	Mean	S.D.	T
Iowa A_1	141	65.79	10.24	77.96	10.90	9.50**
Iowa A_2	138	66.93	12.34	75.75	14.67	5.04**
Iowa C	139	66.48	10.34	76.55	12.43	6.85**
Calif. Test Mental Mat.	136	111.19	16.34	111.34	16.56	.41
Syracuse Test of Algebraic Fluency	131	20.42	3.16	19.25	2.70	2.87**

Table 6
Pre and Post Test Summarization
Grade 6 Experimental

	Pre			Post		
	N	Mean	S.D.	Mean	S.D.	T
Iowa A_1	157	68.8	9.62	79.30	10.01	9.24**
Iowa A_2	157	68.68	13.01	76.95	10.80	5.90**
Iowa C	157	68.99	10.41	78.21	9.47	7.93**
Calif. Test Mental Mat.	134	110.87	16.93	111.64	17.34	.65
Syracuse Test of Algebraic Fluency	145	20.18	3.08	19.72	2.64	1.36*

** Significant at the .0005 level

*Significant at the .05 level

Table 7
Product Moment Coefficient of Correlation
Pre and Post Test
(Grade 4, Control)

Iowa A_1	.66	.94	.72	.66	.76
Iowa A_2		.61	.57	.64	.75
Iowa C			.76	.78	.68
CTMM				.87	.26
STAF					.61
	Iowa A_1	Iowa A_2	Iowa C	CTMM	STAF

Table 8
Product Moment Coefficient of Correlation
Pre and Post Test
Grade 4, Experimental

Iowa A_1	.38	.93	.66	.49	.64
Iowa A_2		.52	.49	.57	.60
CTMM			.66	.55	.43
STAF				.79	.39
					.49
	Iowa A_1	Iowa A_2	Iowa C	CTMM	STAF

Table 9
Product Moment Coefficient of Correlation
Pre and Post Test
Grade 5, Control

Iowa A_1	.59	.91	.75	.60	.72
Iowa A_2		.87	.58	.61	.66
Iowa C			.78	.76	.46
CTMM				.82	.48
STAF					.54
	Iowa A_1	Iowa A_2	Iowa C	CTMM	STAF

Table 10
Product Moment Coefficient of Correlation
Pre and Post Test
Grade 5, Experimental

Iowa A_1	.77	.93	.76	.75	.61
Iowa A_2		.64	.69	.73	.38
Iowa C			.79	.72	.42
CTMM				.79	.42
STAF					.51
	Iowa A_1	Iowa A_2	Iowa C	CTMM	STAF

Table 11
Product Moment Coefficient of Correlation
Pre and Post Test
Grade 6,Control

Iowa A_1	.68	.90	.75	.74	.58
Iowa A_2		.83	.86	.79	.50
Iowa C			.89	.70	.46
CTMM				.69	.27
STAF					.60

	Iowa A_1	Iowa A_2	Iowa C	CTMM	STAF

Table 12
Product Moment Coefficient of Correlation
Pre and Post Test
Grade 6, Experimental

Iowa A_1	.90	.87	.82.	.69	.58
Iowa A_2		.79	.68	.70	.42
Iowa C			.90	.65	.51
CTMM				.81	.35
STAF					.51

	Iowa A_1	Iowa A_2	Iowa C	CTMM	STAF

Table 13
Analysis of Responses to
Madison Mathematics Attitude Questionnaire
Administered October 1961 and May 1962
to Experimental and Control
(Post Administration in Parentheses)

		Per Cent Experimental			Per Cent Control		
		Yes	No	DK	Yes	No	DK
1.	I think about arithmetic problems outside of school and like to work them out.	88(68)	4(10)	8(22)	52(45)	41(40)	7(15)
2.	I don't feel sure of myself in arithmetic.	17(35)	63(52)	20(13)	36(43)	42(39)	22(18)
3.	I enjoy seeing how rapidly and accurately I can work problems	43(62)	33(20)	24(18)	77(79)	12(10)	11(11)
4.	I like arithmetic, but I like other subjects just as well.	25(30)	51(47)	24(23)	74(65)	19(9)	7(26)
5.	I like arithmetic because it is practical.	88(88)	6(3)	6(9)	68(76)	16(14)	16(10)
6.	I don't think arithmetic is fun but I always do well in it.	17(41)	74(35)	9(24)	63(60)	26(19)	11(21)
7.	I am not enthusiastic about arithmetic, but I have no dislike for it either.	67(76)	17(20)	16(4)	55(60)	29(32)	16(8)
8.	Arithmetic is as important as any other subject.	16(45)	69(38)	15(17)	86(70)	10(19)	4(11)
9.	Arithmetic is something you have to do even though it is not enjoyable.	79(81)	13(10)	8(9)	79(90)	14(5)	7(5)
10.	Sometimes I enjoy the challenge presented by an arithmetic problem.	20(56)	71(20)	9(24)	65(68)	22(30)	13(2)
11.	I have always been afraid of arithmetic.	30(50)	50(50)	20(-)	11(25)	81(65)	8(10)

Table 13 (continued)

	Per Cent Experimental			Per Cent Control		
	Yes	No	DK	Yes	No	DK
12. I would like to spend more time in school working arithmetic.	44(51)	37(28)	19(21)	36(40)	54(49)	10(11)
13. I detest arithmetic and avoid using it at all times.	74(62)	20(30)	6(8)	18(30)	71(52)	11(18)
14. I enjoy doing problems when I know how to work them well.	20(41)	68(41)	12(18)	89(79)	8(8)	3(13)
15. I avoid arithmetic because I am not very good with figures.	43(30)	14(43)	43(27)	17(25)	70(68)	13(7)
16. Arithmetic thrills me and I like it better than any other subject.	18(45)	43(32)	39(23)	30(30)	58(48)	12(22)
17. I never get tired of working with numbers.	41(58)	42(32)	17(10)	43(61)	40(29)	17(10)
18. I am afraid of doing word problems.	35(41)	52(49)	13(10)	14(30)	76(52)	10(18)
19. Arithmetic is very interesting.	46(56)	43(35)	11(9)	71(70)	18(22)	11(8)
20. I have never liked arithmetic.	39(35)	48(50)	13(15)	26(39)	62(55)	12(6)

Questionnaire For Madison Project Mathematics Group

Given Orally

1. There is arithmetic in mathematics.
2. There is no arithmetic in mathematics.
3. Mathematics is more fun than arithmetic.
4. Mathematics is less fun than arithmetic.
5. Madison Project of Mathematics has arithmetic in it.
6. Madison Project of Mathematics does not have arithmetic in it.
7. Madison Project of Mathematics is more fun than arithmetic.
8. Madison Project of Mathematics is less fun than arithmetic.
9. I like to work with numbers.
10. I do not like to work with numbers.
11. I like to work with letters instead of numbers.
12. I do not like to work with letters instead of numbers.
13. I like to work with boxes and triangles as well as numbers.
14. I do not like to work with boxes and triangles as well as numbers.
15. I like Algebra.
16. I do not like Algebra.
17. I have worked with Algebra.
18. I have never worked with Algebra.
19. I would like to have harder work in mathematics.
20. I do not want harder work in mathematics.

Questionnaire To All Pupils
Connected With The Experiment

This test gives us some information about boys and girls liking or disliking a subject. Do not worry about your answer. You are not marked on how you answer. Be sure you answer every question.

Remember, that when we talk about arithmetic, we mean the work we do with numbers and figures.

1. I think about arithmetic problems outside of school and like to work them out.

2. I don't feel sure of myself in arithmetic.

3. I enjoy seeing how rapidly and accurately I can work arithmetic problems.

4. I like arithmetic, but I like other subjects just as well.

5. I like arithmetic because it is practical.

6. I don't think arithmetic is fun, but I always want to do well in it.

7. I am not enthusiastic about arithmetic, but I have no real dislike for it either.

8. Arithmetic is as important as any other subject.

9. Arithmetic is something you have to do even though it is not enjoyable.

10. Sometimes I enjoy the challenge presented by an arithmetic problem.

11. I have always been afraid of arithmetic.

12. I would like to spend more time in school working arithmetic.

13. I detest arithmetic and avoid using it at all times.

14. I enjoy doing problems when I know how to work them well.

15. I avoid arithmetic because I am not very good with figures.

16. Arithmetic thrills me, and I like it better than any other subject.

17. I never get tired of working with numbers.

18. I am afraid of doing word problems.

19. Arithmetic is very interesting.

20. I have never liked arithmetic.

21. I think arithmetic is the most enjoyable subject I have taken.

22. I can't see much value in arithmetic.

23. I would like to try something new in arithmetic.

24. I do not like to try any new work in arithmetic.

Reprinted from New York State Mathematics Teachers Journal, April 1960

MATHEMATICS FOR YOUNGER CHILDREN — THE PRESENT STATUS OF THE MADISON PROJECT

Robert B. Davis
Syracuse University and
School Mathematics Study Group, Yale University

The tenth anniversary of AMTNYS is a most appropriate occasion to report on the present status of the Madison Project, which began as a secondary-school program in New York State, and, indeed, owes its origin to some of the same people who have helped build AMTNYS.

The Madison Project was started in 1957 as an experimental mathematics curriculum for some of the weaker students at Madison Junior High School, in Syracuse, New York. After a brief period of work with remedial arithmetic, the Project turned to other mathematical topics — particularly algebra and co-ordinate geometry — thereby acquiring several characteristics which remain even today as features of Project work.

The Project stopped teaching remedial arithmetic to those "low-I.Q." seventh graders, and began instead to work with topics from algebra, as a result of several convictions:

First, we observed these children and felt that they could usually go through a school day without once encountering a real intellectual challenge. To be sure, their performance on various tasks was poor, but the tasks themselves were dull and routine. We thought they might be grateful for some tasks with significant intellectual content — and as we pursued this, we found that they were, indeed, grateful. They took *pleasure* in solving equations, or in graphing

$$\triangle = \square \times \square.$$

or in finding the area of a parallelogram. Their entire schoolwork showed improvement, and their tendency toward absenteeism was markedly decreased.

Second, we felt that mathematics was intrinsically a matter of original discovery and creative thinking; if we did not give children *practice* in original discovery and creative thinking, then we were not teaching them mathematics. We were able to devise far more *discovery* situations in algebra than we were in arithmetic — or, at least, the algebraic discoveries had a more exciting feel to them than those that we knew in arithmetic.

Finally, without "placeholder" notation and "open sentences" (this, of course, is *modern* language for "variables" and "equations"), we could never make any general statements about numbers. An even number, for example, can be written $2 \times \square$ — but only if we understand some form of placeholder notation such as "$\square$".

This early work with weak students (call them, if you prefer, "low-I.Q." students — they did test with I.Q.'s in the 80's, but there is some doubt as to what this really means) has been described elsewhere.[1] More recently, Project work with weak students has been concentrated in grade 9 and in grade 6.

For the most part, recent Project work has dealt with average or bright children. It was in this connection that we made what we still regard as our most exciting discovery: average and bright children in grades 4, 5, and 6 possess a remarkable ability to handle abstract mathematics. When we have conducted a fourth-grade class side-by-side with a seventh-grade class, it has nearly always proved difficult (or impossible) to move ahead as fast with the seventh graders as we have with the fourth graders.

That is to say, if, in September, we begin teaching our introductory algebraic material to a fourth-grade class, and if we simultaneously begin to teach this same material to a seventh-grade class who have never previously studied algebra, the fourth-grade class will nearly always approach the subject with more pleasure, with more insight, with more creative power, with more enthusiasm, and with more success.

This, it seems to us, is a major discovery.

It is not, however, original (not that that really matters). Similar successes in teaching abstract mathematics to elementary school children have been experienced by Professor David Page's project at the University of Illinois, by Professor W. W. Sawyer at Wesleyan University, and also by others.

We have known for some time that young children can learn a language with a facility that older people cannot usually equal. A precisely similar situation appears to exist in the study of mathematics, in the words of Professor Page:

> It has usually been believed that one had to wait until a child was older before introducing him to abstract mathematics. This idea is precisely wrong: it is not that one *has* to wait, but rather that one *cannot afford to wait.*

From the experiences of the Project, we know that the material can be introduced as early as grade three. At this level it is eagerly received, although we are not disposed to try for too much with children of this age.

The greatest achievement with abstract mathematical material has occurred, for us, in grades four and five. This seems to be far and away the best place to begin the serious study of abstract mathematics. Our fourth grades, as one example, easily discover *for themselves* how to solve quadratic equations, and they derive unmistakable pleasure from this sort of intellectual activity.

---

1) *M.I.T. Technology Review*, 62, 2:28-30 (December 1959)

The Method of Presentation

Without a doubt, the method of presentation used in Project classes is closely related to the response of children of different ages. One important feature of this presentation is that the teacher gets the children thinking about certain questions or problems, and it is from their own thinking about these problems that the children learn. There is next to no exposition — notations are usually learned by imitation, and techniques and insights are gained by self-discovery. (Obviously, the first problems of a sequence must be so fundamental that even the slowest student can make progress with them: for example, we might begin the first day's lesson with

$$3 + \square = 5,$$

and then go on, in subsequent problems, to

$$3 + (2 \times \square) = 11$$

and

$$1 + (2 \times \square) = 6.)$$

This method of presentation has posed two tantalizing problems: for one thing, we are eager to study this method, to see if we can discover why it does work so well with fourth and fifth graders, and to understand the method as fully as possible. It is easier to *use* this method of teaching than it is to *analyze* the method and find out how it actually works. We would like to know, for example, far more about the cues which the students give to the teacher, and which the teacher gives to the students, whether by gesture, inflection, posture, or otherwise. Such cues are important in determining the direction in which the class discussion will move.

The second challenge is more practical: we are eager to share this technique with all other teachers who are interested. We have, as yet, found no really satisfactory way to do this. We do have two partial solutions: teachers who are able to do so, are welcome to visit Project classes (for example, at Weston, Connecticut, or at North Haven, Connecticut). Also, a "workbook" and "teacher's manual" have been prepared and are sold at slightly less than their actual cost of production (with an unfortunate resultant drain on the Project treasury).

(Anyone wishing to visit the Project classes at Weston, Connecticut, should write to: Mrs. Beryl Cochran, Weston Public Schools, Weston, Connecticut; anyone wishing to visit classes at North Haven should write to the Ridge Road School, North Haven, Connecticut; to visit classes in Syracuse, New York, write to: Mr. William Bowin, Board of Education, Syracuse Public Schools, West Genesee St., Syracuse, N. Y.; copies of the workbook and teacher's manual may be obtained by sending $4.00 to Miss Carol Bowerman, Mathematics Department, Syracuse University, Syracuse 10, N. Y.)

Building a Local Program

What does the Madison Project have to offer to a school that is thinking over its curriculum? This question, also, has several partial answers. It is our feeling that a good math program in a school must nearly always be a local product. Nationwide or statewide programs can be of great value to a school that is building its own program — but the job of building a good sequence of courses has to be done right there on the spot. A school builds a program for *its* students, to be developed and taught by *its* teachers. You cannot order a curriculum ready made, any more than you can order a landscape ready made.

Since we believe this, we have not tried to develop a "Madison Project curriculum" that can be adopted and installed, with no local effort. Quite the contrary: the Madison Project workbook has been designed for maximum flexibility — a school can introduce this material as early as grade three (as at Weston, Conn.), or as late as grade eight (a private school in New Haven does this). Madison Project algebra can be studied one period per week, or for several periods each week. It can be *in addition to* a full program of arithmetic studies, or it can be integrated into the arithmetic program. In the elementary grades, it can be taught by the regular classroom teacher, or by a special "algebra" teacher who visits the class once or twice a week. It can be used with gifted children (as at Weston, Conn., and at Syracuse, N.Y.), or it can be used with weak ("low I.Q.") students (both Weston and Syracuse also do this). One school plans to use Madison Project material to lead into the UICSM-Illinois-Beberman material by grade eight or nine; elsewhere the Madison Project material is used to lead into "traditional" high school work, or into grade 9 of the S.M.S.G. (Yale) material.

In order to make the process as painless as possible, we recommend that a school introduce the Madison Project material primarily as *enrichment* material — without necessarily striving for any large change in the curriculum. We also recommend that elementary and secondary teachers work together in doing this. From a gradual beginning of this sort, it is possible to evolve a strong program of mathematical studies for younger children.

It is our belief that the natural learning rate for young children has been seriously mis-estimated — especially in relation to mathematical abstractions. Here is a place where a revolution in the curriculum is very likely to occur.

But, as W. W. Sawyer has remarked, a revolution depends, not upon finding a sufficiently *large* step forward, but rather on finding a sufficiently *small* step forward, so that we can actually take it.

If you wish to experiment with this sort of material in your school, I wish you luck in finding a sufficiently small step. Those of us who work with the Madison Project will be glad to help you in any way that we can.

Elementary • GRADES 4·5·6·7·8 • 1957 S-Form

California Short-Form Test of Mental Maturity

Devised by

ELIZABETH T. SULLIVAN, WILLIS W. CLARK, AND ERNEST W. TIEGS

E

S-57

INSTRUCTIONS TO PUPILS

This is a test of mental maturity. In taking it you will find out how well you understand and what you do with the problems. We are interested to do this right seventh. But you should answer as many items as you can. Work as fast as you can without making mistakes.

DO NOT WRITE OR MARK ON THIS TEST BOOKLET UNLESS YOU ARE TO DO SO IN THE DIRECTIONS

17th Printing

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IOWA TESTS of BASIC SKILLS

MULTI-LEVEL EDITION FOR GRADES 3-9

FORM 2

Prepared at the State University of Iowa under the direction of

E. F. Lindquist and A. N. Hieronymus

With the assistance of: JULIA PETERSON · ROLLAND RAY · LEONARD FELDT
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TEST A: ARITHMETIC SKILLS

Test A-1: Arithmetic Concepts

Directions: This is a test of how well you understand the number system and the terms and operations used in arithmetic.

Four answers are given for each question, but only one of these answers is right. You are to choose the one answer that you think is better than the others. Then, on the answer sheet, find the row of circles numbered the same as the exercise. Fill in the circle for the best answer.

Use this table to find where your grade is to begin and stop on this test.

	BEGIN WITH	STOP AFTER
GRADE 3	Exercise 1 on page 77	Exercise 30 on page 79
GRADE 4	Exercise 18 on page 78	Exercise 51 on page 80
GRADE 5	Exercise 51 on page 79	Exercise 75 on page 82
GRADE 6	Exercise 52 on page 81	Exercise 98 on page 83
GRADE 7	Exercise 73 on page 82	Exercise 120 on page 85
GRADES 8 AND 9	Exercise 99 on page 83	Exercise 150 on page 86

3

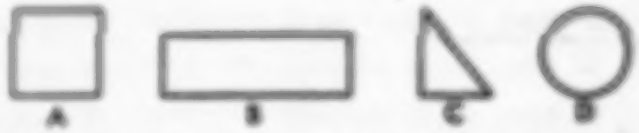
1. In the picture above, which building is the tallest?
   1) House
   2) Church
   3) Hotel
   4) Theater

2. What is the fourth month of the year?
   1) April
   2) September
   3) July
   4) November

3. Which of these pictures shows that 15 means 1 ten and 5 ones?
   1) ••• ••••
••• •••
   3) •• •••••
•• ••••
   2) ••••• ••
••••• •
   4) •••• •••
•••• ••

4. What number is <u>next smaller</u> than 30?
   1) 20
   2) 29
   3) 25
   4) 31

5. How would you write 6 tens and 3 ones in figures?
   1) 6103
   2) 613
   3) 603
   4) 63



6. Which of the figures above is a rectangle?
   1) A
   2) B
   3) C
   4) D

MAKE NO MARKS IN THIS BOOKLET

7. Which of these groups of coins is equal in value to a half dollar?
   1) 25 pennies
   2) 5 nickels
   3) 10 dimes
   4) 2 quarters

8. What time is it by this clock?
   1) Half past two
   2) Quarter past six
   3) Quarter to six
   4) Half past three

GO ON TO NEXT PAGE

Test A-2: Arithmetic Problem Solving

Directions: This is a test of your skill in solving arithmetic problems.

The problems in the test are like the samples shown at the right. After each problem are three possible answers and a "Not given" — meaning that the correct answer is not given.

Work each problem and compare your answer with the three possible answers. If the correct answer is given, fill in the circle on the answer sheet that has the same number as the right answer. If the correct answer is not given, fill in the fourth circle.

The sample exercises show you what to do.

SAMPLE EXERCISES

S1. On Saturday Steve worked 3 hours for Mrs. White and 2 hours for Mrs. Bell. How many hours did he work altogether?

1) 4 3) 6
2) 5 4) (Not given)

S2. Ruth made 4 pies and set them out to cool. Her dog ate 2 of them. How many did she have left?

1) 4 3) 1
2) 3 4) (Not given)

ANSWERS

S1. ① ● ③ ④

S2. ① ② ③ ●

Use this table to find where your grade is to begin and stop on this test.

	BEGIN WITH	STOP AFTER
GRADE 3	Exercise 1 on page 87	Exercise 25 on page 89
GRADE 4	Exercise 13 on page 89	Exercise 39 on page 91
GRADE 5	Exercise 28 on page 90	Exercise 54 on page 92
GRADE 6	Exercise 40 on page 91	Exercise 70 on page 93
GRADE 7	Exercise 55 on page 92	Exercise 86 on page 94
GRADES 8 AND 9	Exercise 81 on page 93	Exercise 96 on page 95

3

1. One day after school, 23 of the third grade pupils went coasting on Moss Avenue hill. Only 9 of the children had sleds. How many did not have sleds?

1) 15 3) 4
2) 14 4) (Not given)

2. John and Jim took turns using John's sled. John coasted down the hill 9 times and Jim 8 times. How many slides did they make altogether?

1) 15 3) 18
2) 16 4) (Not given)

3. Stan kept 8 chickens from last year's flock. His father bought 25 baby chicks for him. How many chickens did Stan have then?

1) 23 3) 33
2) 25 4) (Not given)

4. Stan's father paid $2.70 for the baby chicks and $1.25 for feed. How much did he spend altogether?

1) $3.95 3) $3.50
2) $3.90 4) (Not given)

GO ON TO NEXT PAGE ▶

PART I

Can you fill the triangle, △, with the correct number?

Whenever you see a circle, ○, put the number three, 3, in it's place. Example: $6 = ○ + △$

$6 = 3 + ?$

$6 = 3 + 3$

1. $○ + △ = 5$

2. $2 + △ = 10$

PART I (cont'd)

3. △ - 10 - 5

4. 7 = △ + ○

5. △ + ○ = 8

6 ○ - 1 = △

7. 13 = ○ + △

8 △ = 2 ½ + ○

9. △ - 5 = 0

10. △ - 0 = 3 ½

PART II

These symbols stand for these numbers: $\varphi = 1$; $\chi = 2$; $\lambda = 3$; $\xi = 4$

Using these symbols, solve the following problems by putting a circle around the correct answer at the right.

X- means times or multiply

Example: $\lambda \times \xi = ?$ $\chi\varphi$ $\varphi\chi$ $\lambda\chi$ $\xi\varphi$

$3 \times 4 = 12$

$12 = \varphi\chi$

1. $\varphi + \chi = ?$ φ χ λ ξ

2. $\xi \times \lambda \times \varphi = ?$ $\varphi\chi$ $\chi\varphi$ $\lambda\lambda$ $\xi\varphi$

$\varphi=1;\ \varkappa=2;\ \lambda=3;\ \xi=4$

PART II (cont'd)

X means times or multiply

3. $\frac{\varphi}{\varkappa} + \frac{\varphi}{\varkappa} = ?$ φ $\varkappa$ λ ξ

4. $\lambda\varkappa = \varkappa \times \xi\ X\ ?$ φ $\varkappa$ λ ξ

5. $\boxed{\varkappa X\ ?} - \varphi = \lambda$ φ $\varkappa$ λ ξ

6. $? = \boxed{\lambda \times \varkappa \times \xi} - \varphi\varkappa$ $\varphi\xi$ $\varphi\varkappa$ $\varkappa\lambda$ $\varphi\varphi$

PREPARED BY - Mathematics Dept.
Research Dept.
City School District
Syracuse, New York

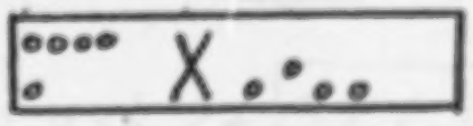
PART III

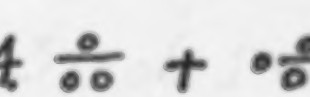
Find the answer to the following problems:

X - means times or multiply

1. =

2. =

3.  =

4.  =

5.

PART IV

Zob in Indian talk means "is smaller than".

Find a whole number or group of whole numbers which would make the following problems correct.
X- means times or multiply. Example: 6 zob (7) zob 10
6 zob (7,8,9) zob 10

-37-

1. 1 zob (?) zob 3 ( )
2. 2 zob (?) zob 8 ( )
3. 1 zob 2+ [3X(?)] zob 10 ( )
4. 3 zob 1+ [2X(?)] zob 12 ( )

Addendum to U. S. Cooperative Research Project No. 1193
Madison Mathematics Project Grades 4-5-6

A. In keeping with the conditions of contract, and abiding by the request of Commissioner Woollatt, the following data are transmitted as addenda to the original report:

A Comparison of Experimental and Control Post Test Means on the Iowa Test of Basic Skills, Arithmetic Sub-Section, and the Syracuse Test of Algebraic Fluency

(description of test instruments follow)

Grade 4 Total

Test	E Mean	C Mean	T
ITBS A_1	56.15	53.67	1.73
ITBS A_2	56.57	54.92	1.07
ITBS Total A	56.45	54.18	1.51
Syracuse Test of Algebraic Fluency (STAF)	19.31	17.37	3.67*

*significant .001 level

Grade 4 (High I.Q.)

Test	E Mean	C Mean	T
ITBS A_1	57.82	59.97	-1.66
ITBS A_2	59.36	60.95	-.84
ITBS Total A	58.63	60.73	-1.33
STAF	19.93	19.64	.46

Grade 4 (Average I.Q.)

Test	E Mean	C Mean	T
ITBS A_1	54.25	52.44	-.82
ITBS A_2	52.75	52.95	-.08
ITBS Total A	53.75	52.56	.53
STAF	20.61	16.90	4.50*

*.001 level

Grade 4 (Low I.Q.)

Test	E Mean	C Mean	T
ITBS A_1	50.37	41.46	2.10*
ITBS A_2	48.12	46.42	.44
ITBS Total A	49.37	42.06	2.09*
STAF	16.72	13.94	2.33*

*significant .05 level

Grade 5 (Total)

Test	E Mean	C Mean	T
ITBS A_1	60.17	60.72	-.35
ITBS A_2	59.34	61.95	1.38
ITBS Total A	60.90	61.62	-.43
STAF	17.49	18.02	1.08

Grade 5 (High I.Q.)

Test	E Mean	C Mean	T
ITBS A_1	67.08	66.11	.61
ITBS A_2	70.21	67.92	.84
ITBS Total A	68.94	67.11	.98
STAF	20.08	19.53	1.05

Grade 5 (Average I.Q.)

Test	E Mean	C Mean	T
ITBS A_1	56.87	57.67	-.39
ITBS A_2	55.42	57.62	-.85
ITBS Total A	56.25	58.18	-.86
STAF	16.87	17.55	-1.05

Grade 5 (Low I.Q.)

Test	E Mean	C Mean	T
ITBS A_1	45.50	59.00	-4.20*
ITBS A_2	48.66	61.89	-4.65*
ITBS Total A	45.41	60.52	-5.34*
STAF	14.64	16.64	-1.65**

Grade 6 (Total)

Test	E Mean	C Mean	T
ITBS A_1	79.94	78.55	1.06
ITBS A_2	77.79	76.51	.73
ITBS Total A	78.94	77.33	1.10
STAF	19.85	19.35	1.47

Grade 6 (High I.Q.)

Test	E Mean	C Mean	T
ITBS A_1	86.62	85.03	1.21
ITBS A_2	83.76	85.13	-.59
ITBS Total A	85.33	85.20	.08
STAF	20.79	20.53	.83

*significant .001 level
**.05 level

Grade 6 (Average I.Q.)

Test	E Mean	C Mean	T
ITBS A_1	77.10	76.79	.18
ITBS A_2	74.37	73.21	.58
ITBS Total A	76.02	74.78	.65
STAF	19.44	19.30	.28

Grade 6 (Low I.Q.)

Test	E Mean	C Mean	T
ITBS A_1	67.94	64.78	1.10
ITBS A_2	69.73	62.22	2.66*
ITBS Total A	69.05	63.33	2.20*
STAF	18.11	15.83	1.87*

*significant .05 level

(Note: Means as listed in this addendum tend to differ from those originally published due to elimination of those pupils with no I.Q. score available.)

Section B - Interpretation of findings

In the original presentation of results for the current project, a comparison of means was made within experimental and control groups. The present analysis compares differences and means between groups. A simple "T" test was the method of comparison.

In determining any non-chance variation, an analysis was made of each grade for experimental and control groups. The grade was then broken down into high, average, and low I.Q. levels as measured by the California Test of Mental Maturity. Separate means were computed for each subgroup. The means involved were; Iowa Test of Basic Skills, section A_1, Iowa Test of Basic Skills, section A_2, Iowa Test of Basic Skills, compositive arithmetic score, Syracuse Test of Algebraic Fluency. Comparisons were made for the post test only.

In examining the results for grade four total, we find no significant differences until the STAF results were analyzed. A significant "T" (.001 level) was discovered. For the average I.Q. in grade four, the experimental group mean for the STAF test again was significantly higher than the control group mean. For the low I.Q. in grade four, three significant differences were noted; ITBS A_1, ITBS total arithmetic and the STAF test.

The grade five results render comparable means until we examine the low I.Q. subgroup. For this group, the control group mean was significantly higher in every test area.

Grade six results again revealed significant differences for the low I.Q group in three of the four tested areas. It is apparent

that except for grade five, the low I.Q. pupils appear to be achieving at higher levels than their control group counterparts. It was expected that because the STAF was designed specifically for the experimental groups, that they would perform significantly higher on this test than with the control groups. In some cases this was not true.

The vast differences in the low I.Q. group for grade five are indeed puzzling. In each case the control group did almost a full school year better based on national norms. However, in examining the results for the experimental group more closely it was discovered that several very low scores tended to depress the computed mean.

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"Testing Procedures and Importance for Evaluation"

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"Problem Solving"

(November 21, 1961)

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Guests from Corning, New York

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and visiting professors

Senior mathematics majors
State University College, Oswego

and others